“The Master Alloy of Al-Nb-B”

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• Motivation
• Master Alloy Design
• Production Process Development
• Application as Grain Refiner
• Future

For the aluminium and automotive industries
The use of niobium as grain refining compound NbB₂ for Al-Si cast parts

Benefits:

- **Castability/Soundness of thin and complex parts**
- **Less porosity and hot tearing**
- **Increase of mechanical properties/thoughness**
- **Better homogeneity of properties**
- **Potential weight savings of up to 30% with no loss of strength**

Materials:
- Nb metal powder (<45 um)
- KBF₄

Reactions:

\[ 2\text{KBF}_4 + 3\text{Al} \rightarrow \text{AlB}_2 + 2\text{KAlF}_4 \]
\[ \text{Nb} + 3\text{Al} \rightarrow \text{Al}_3\text{Nb} \]
\[ \text{Al}_3\text{Nb} + \text{AlB}_2 \rightarrow \text{NbB}_2 + 4\text{Al} \]
\[ 2\text{Nb} + 2\text{KBF}_4 + 5\text{Al} \rightarrow \text{NbB}_2 + \text{Al}_3\text{Nb} + 2\text{KF} + 2\text{AlF}_3 \]

Challenges: Dissolution, yield and cost

Al-(5)%Nb Master Alloy

High Nb alloy

 Nb(60-80%)-Al

Niobium Metal (Nb°)

\((\text{Al}_3\text{Nb})\)
Main phases:

- Al
- $\text{Al}_3\text{Nb}$
- $\text{AlB}_2$
- $\text{NbB}_2$
- $\text{Nb}_2\text{B}_3$
Formation of nucleation sites:

\[ \text{Al}_3\text{Nb} + \text{AlB}_2 = \text{NbB}_2 + 4 \text{ Al} \quad [1] \]

\[ 4 \text{Al}_3\text{Nb} + 3 \text{AlB}_2 = 2 \text{Nb}_2\text{B}_3 + 15 \text{ Al} \quad [2] \]
June 2015 e March 2016: Lab scale trials

- **Results:** High grain refining of Al-Si alloys for Nb ≥ 0.05wt%
- **Decision:** Validate the industrial application of the grain refiner
Result: High grain refining in as cast ingots

May 2016: 1st Industrial validation trial

0.1% Nb

Grain refining + Casting

Grain refined Al-Si ingots

As Cast

Reference 0% Nb

Grain refined (0.1% Nb)

As Cast

Reference

Result: High grain refining in as cast ingots
May 2016: 2\textsuperscript{nd} Industrial validation trial

0.1\% Nb

Grain refined Al-Si ingots

Ingot remelting trials

Result: High grain refining after remelting
May & June 2016: 3rd Industrial validation trials

High grain refining (from 3mm to < 0.3 mm)

- 0.05%Nb
- 0.10%Nb
- 0.15%Nb

- 0% Nb
- High porosity
- 0.15%Nb
- No porosity
Future: Global CO₂ Emissions & Standards

50 years of growth in the North American automotive market

Niobium Microalloyed Steel + Niobium Grain Refined Aluminum Alloys for a sustainable world
Thank you!